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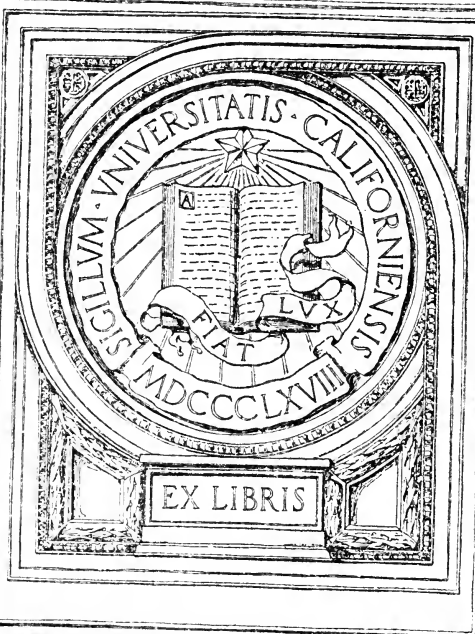
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# INVESTIGATION OF THE ECONOMIC STATUS OF NON-GAME BIRDS.

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University of California.

With Figures 1-8.

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## LETTER OF TRANSMITTAL.

EAST HALL, UNIVERSITY OF CALIFORNIA,  
BERKELEY, CAL., Sept. 16, 1912.

*The Honorable Board of Fish and Game Commissioners for the State  
of California.*

GENTLEMEN: I have the honor to submit herewith a report on the Bird investigations from the commencement of the work, January 1, 1911, to June 30, 1912.

The work of this department has consisted in the accumulation and publication of data regarding the relations of certain non-game birds to the agricultural interests of the State. Four methods have been used in the work—field investigation, experimentation, laboratory examination of stomachs, and circulars of inquiry.

Field investigation has been depended on to furnish data as to the depredations of birds, and as to the kind, quantity, and preference of food. Investigations of the relations of birds to insect outbreaks have been fruitful of valuable information as to the part played by birds in helping to maintain an equilibrium.

Experimentation has been relied upon to furnish evidence as to the kind, quantity, and the preference of food of nestlings, and the time of digestion.

Emphasis has been placed on the laboratory examination of stomachs, as this affords the most reliable information as to the food of birds.

Reports from the men most directly concerned are being depended on to furnish information as to the extent of the depredations of certain birds, and as to how they are regarded by those who are in a position to know their relations to agriculture.

It seemed best to concentrate effort on those birds of whose depredations most complaint has arisen in recent years. Endeavor has therefore been centered on the western meadowlark (*Sturnella neglecta*), the blackbirds (*Agelaius phœniceus* subsp.), (*Agelaius bicolor*), (*Euphagus cyanocephalus*), the western robin (*Plantesticus migratorius propinquus*), the horned lark (*Otocoris alpestris* subsp.), the western mourning dove (*Zenaidura macroura marginella*), and the road-runner (*Geococcyx californicus*). Collections of these birds taken every month of the year, and in over twenty-five different localities in the State, have been made by the deputies of the Commission, and are now on hand in process of examination. Over eight hundred and thirty stomachs of meadowlarks have been examined in the laboratory, and their contents analyzed and tabulated. A final report on the economic status of this bird is in the course of preparation.

There is little positive information available regarding the abundance, distribution, migration, and food-habits of the game birds of the State. This information is necessary to a sane conservation policy.

It is the desire of this department to extend its work to include the game birds, and so be able to furnish this information.

It is hoped that this department, by furnishing positive data as to the food of certain non-game birds, and as to the life histories of the game birds of the State, may correct the widespread ignorance on these subjects, and may thus promote needed interest and protection, the principal factors in a sane conservation policy.

Respectfully submitted.

H. C. BRYANT,  
In Charge Bird Investigations.

## HISTORY OF THE INVESTIGATION.

The total extinction of the passenger pigeon and the near extinction of several other birds is bringing to the American people convincing evidence of the necessity of a thorough knowledge of the economic value of birds. The large number of publications on the food habits of birds issued by the U. S. Biological Survey and the State Agricultural Experiment Stations also confirms the view that this work is of great importance. California, with her well developed fruit and grain industries and her abundant supply of bird and animal life, must necessarily become more and more interested in the conservation of those birds and animals known to be beneficial, and in the extermination of those known to be harmful.

It is a well known fact that certain birds continually give trouble by destroying crops. Some of these same birds do an incalculable amount of good by destroying certain pests such as mice and insects which are injurious to vegetation. Still others because they have both good and bad habits do not belong to either class. Opinion as to the real value of certain birds varies greatly. This is often due to the fact that but little is known of their real food habits.

Continued complaints from the farmers and fruit growers of the State have been made to the California Fish and Game Commission regarding the losses to crops caused by the depredations of certain birds. The Commission has been urged repeatedly to take strong measures to avert the damage done. The usual measure urged is that the particular bird in question should be placed on the unprotected list. On the other hand, many scientists and others interested in birds, have pointed out the fact that birds not only confer a great benefit in keeping down the number of injurious insects and weed seeds, but also that they fill a niche in that balance of nature most suited to mankind which cannot be and is not filled by any other form of life. Man profits greatly by the services of birds, but not appreciating it, he returns evil for good. Experience has shown that many of those complaining of the depredations of birds have based their complaints on circumstantial evidence, or on evidence not sufficiently reasoned out. Furthermore, these complaints have brought out the fact that really very little is known of the food habits of birds throughout the whole year. Certain it is that a complete knowledge of the food habits of a bird is necessary to a determination of its economic status. As a result, therefore, the California Fish and Game Commission has felt that legislation should be based on comprehensive scientific investigations as to the value of birds, and not on circumstantial evidence. Consequently, an investigation into the relations of the birds of the State to agricultural and other interests was instituted.

In order that the investigation be both scientific and practical, it was determined to obtain precise knowledge of the food of birds by field

work, supplemented by stomach examinations of birds taken in many different parts of the State each month in the year. Both of these lines of investigation are important as they each supplement the other.

A thorough knowledge of the nature and extent of the damage done by certain of our birds, combined with a full understanding of their value to the agriculturist as insect and weed-seed destroyers, such as is being made available by this investigation, will be of inestimable value to the rancher. For certain it is that the successful farmer of today and of the future will have to be able to estimate the status of the birds on his farm with reference to his own interests and to those of the community, and adopt measures accordingly.

Nor should the results of the investigation be interesting to the agriculturist alone. The United States Supreme Court has ruled that game and wild birds belong to the people and not to individuals. Information as to the value of this asset becomes important, therefore, just as information as to the value of forests is important. Consequently the present investigation deserves the interest and support of not alone those directly involved, but of all those interested in the conservation of a national resource.

Through the co-operation of the University of California, there have been afforded not only suitable laboratories for the work of stomach examination, but also the advice and help of Professor C. A. Kofoid of the Department of Zoology, Mr. Joseph Grinnell, Director of the Museum of Vertebrate Zoology, and Professor C. W. Woodworth of the Department of Entomology, as well as others connected with that institution.

## THE INVESTIGATION AS TO METHOD.

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### FIELD INVESTIGATION.—A STUDY OF THE BIRD AT THE SCENE OF ACTION.

The attempt has been made to combine the best of the methods heretofore used by economic ornithologists, and to supplement these methods by new ones of value. We believe the following improved methods in determining the economic status of birds will tend to a nearer attainment of the end sought—a reliable estimation of the economic value of a bird.

1. Complete data as to the birds collected for stomach examination is furnishing information as to the variation in kind, amount, and preference of food of a bird, according to the hour, day, week, month, year, environment, and sex.

2. The use of a combination of methods of stomach examination is tending to decrease personal error, and is allowing a more accurate determination of the food habits.

3. The food capacity of different birds is being determined by a measurement of the volume of food in cubic centimeters.



4. Experimentation is affording data as to the amount, kind, and preference of food, and to the time of digestion.

5. Field investigation is furnishing evidence as to the depredations of birds, their general habits and abundance, and their value in maintaining a natural equilibrium of insect life.

6. Investigations which have been undertaken to determine the relation of birds to insect outbreaks are demonstrating the economic value of birds at such times.

7. A comparison of all the helpful qualities of a bird with all of its qualities injurious to the welfare of mankind is affording a dependable criterion of its economic status.

Next to the knowledge of the food of a bird in determining its economic status, is a knowledge of the habits of a bird. Its abundance, feeding habits, nesting habits, food preferences, its depredations, etc., are all factors that must be considered. Evidence along this line can be afforded only by field investigation.

The field work carried on thus far can be grouped under three heads: studies of the abundance, feeding habits, nesting habits, etc.; studies of the food of birds; and studies of the relation of birds to insect outbreaks.

#### **STUDIES OF THE ABUNDANCE, FEEDING HABITS, NESTING HABITS, ETC., OF BIRDS.**

A month's time has been spent at Lathrop, San Joaquin County, California, studying the abundance, feeding habits, nesting habits, depredations, etc., of birds, especial attention being given to the meadowlark and blackbird. This particular locality was chosen because it afforded not only an abundance of birds, but also a favorable proportion of cultivated and uncultivated land, thus allowing a study of food preference.

Censuses and studies of the rate of reproduction have been carried on to ascertain the relative abundance. Work in the spring of 1911 and 1912 substantiated the fact that meadowlarks, Brewer blackbirds, and red-winged blackbirds usually nest twice each year.

The average brood of the meadowlark is four, although the number of eggs laid is usually five. Second nestings examined have usually showed an incomplete set of eggs. A preference for pasture land for nesting sites was shown, at least 86 per cent of those found being so situated. The time of incubation was found to be fourteen to sixteen days. The young stay in the nest but a short time (eight to ten days). Nestlings are subject to many enemies, such as the skunk, weasel, mice, and hawks, and the number of broods successfully reared is less than that of most other birds. That over 15 per cent of the nests in most localities are destroyed by predaceous animals and birds seems a very conservative estimate.

These facts have an important bearing on the economic relations of the meadowlark. Their particular habitat influences the amount of damage done, due to the locality in which they are found. Their rate

of reproduction influences the amount of damage due to the number of individuals to be expected in any locality.

#### STUDIES OF THE FOOD OF BIRDS.

No small part of the field work has consisted in investigations of the damage caused by birds. In most cases the field work has been supplemented by stomach examinations.

Investigations of the damage caused by meadowlarks has led to the following conclusions:

1. The western meadowlark (*Sturnella neglecta*) is destructive in sprouting grainfields, because of its habit of drilling down beside the sprout and pulling up the kernel. The amount of damage done is dependent on the particular location, the abundance of the birds, the



FIG. 1.—Holes drilled by western meadowlarks in pulling sprouting grain. Photograph taken by H. C. Bryant, at Lathrop, San Joaquin County, California, February 28, 1912.

character of the soil, and the kind of grain. The damage to oats is greatest; wheat suffers considerable damage, whereas barley suffers but little. Broadcasted grain suffers more than drilled, because not being sowed so deeply, it is more easily obtained by meadowlarks. The birds often follow the drill row, however, and pull almost every kernel (Fig. 1). Occasionally, where meadowlarks are very numerous and the quantity of grain small, fields have had to be resown. The real amount of damage done has evidently been overestimated, for fields apparently badly damaged have given the average yield later in the year. After the second and third leaf appears on the grain, the bird can do little damage. This fact reduces the duration of their depredations to less than two weeks, and consequently minimizes the amount of destruction possible.

2. Investigation of complaints that meadowlarks are destructive to melons has shown that damage caused in this way has been exaggerated. Melon growers, although admitting that the birds cause considerable damage, have often been unable to demonstrate the actual damage in the field. Of two melon growers in the vicinity of Dinuba, whose names were handed in as men who were greatly troubled, one returned a verdict of "not guilty" and the other admitted that the damage was not



FIG. 2.—Red-winged blackbirds feeding on kafir corn. Photograph taken by H. C. Bryant, at Lathrop, San Joaquin County, California, October 3, 1912.

very great. All of the growers report that as soon as there are broken melons in the field the birds cease to be troublesome. From the evidence obtainable, it appears that the meadowlark drills into melons to obtain water. The placing of water in a field as an experiment would doubtless confirm or abrogate this view. Such an experiment is contemplated.

3. Censuses have demonstrated that the western meadowlark prefers grass land to cultivated land, nearly 50 per cent more birds being found on the first named.

Investigation of the damage caused by blackbirds has led to the following conclusions:

1. Red-winged blackbirds (*Agelaius phœniceus* subsp.) and (*Agelaius tricolor*), because of their greater abundance and their food habits are by far the most destructive of the blackbirds.

2. The percentage of insect food taken by Brewer blackbirds (*Euphagus cyanocephalus*) is much greater than that taken by red-wings.

3. Red-winged blackbirds are destructive to barley when "in the milk." Ranches within ten miles of rivers or other breeding grounds are the most affected. The amount of destruction varies greatly with the abundance of the birds.

4. Red-winged blackbirds are destructive to Egyptian corn and kafir corn (Fig. 2). They appear to be especially fond of this sort of grain and will gather in flocks of thousands, often causing considerable damage, especially near rivers where the birds are abundant. Small fields of this sort of grain are often completely stripped by the birds. Milo maize suffers little damage if these other grains are available. Protection of fields by scarecrows or by shooting has proved unsuccessful.

An investigation of the damage to almonds caused by the Lewis woodpecker (*Asyndesmus lewisi*) showed that this bird was destructive to almonds in certain localities, in the spring of 1912. The almond growers of the Capay Valley apparently suffered the most, and probably with good reason, for in this particular valley the birds were especially abundant. Over 65 per cent of all the food eaten by the birds examined was made up of small pieces of almonds. The exceptionally dry year which caused a shortage in the usual food supply, was probably responsible for this unusual occurrence.

#### STUDIES OF THE RELATION OF BIRDS TO INSECT OUTBREAKS.

A study of these same birds at the time of an insect outbreak has shown them to be important in the restoration of that balance of nature most suited to mankind. In the investigation of an insect outbreak in northern California during the spring and summer of 1911, when the nymphalid butterfly (*Eugonia californica*) became abnormally abundant, it was found that the Brewer blackbird was the most efficient destroyer of the insects, both on account of its numbers and its food habits, taking 95 per cent of all the butterflies taken by birds. Examination of the stomachs of thirteen red-winged blackbirds (*Agelaius phœniceus* subsp.) showed that over 93 per cent of their food was of vegetable matter. The Brewer blackbirds (*Euphagus cyanocephalus*) examined, on the other hand, had taken 83 per cent of animal food, showing the vast difference in food habits. Meadowlarks were found to feed on the butterflies to a small extent, as was also the western kingbird (*Tyrannus verticalis*), the blue fronted jay (*Cyanocitta stelleri frontalis*), and the Say phoebe (*Sayornis sayus*).

## EXPERIMENTATION.

### EXPERIMENTS WITH CAPTIVE BIRDS.

Experiments to determine the kind and quantity of food, and the time of digestion have been carried on. Nestling birds, because they were most available, were used in the experiments. The birds were not allowed any food for a long enough time to insure an empty stomach. They were then fed a certain amount of food. After varying periods of time they were killed and the stomachs and intestines examined. The position and condition of the food (recognizable hard parts) in the stomach and intestines at intervals after feeding, afforded evidence as to the time of digestion. Evidence as to the food of nestlings has also been obtained. A daily weighing of the nestlings and their excreta has furnished evidence as to the quantity of food required.

The results can be summed up as follows:

1. Meadowlarks have a great capacity for food. A nestling was fed twenty-eight grasshoppers (one half inch in length) inside of fifteen minutes.
2. The time of digestion of grasshoppers and beetles is two to four hours. Cut worms are digested more quickly.
3. The time of digestion of grain (wheat) is three to six hours.
4. Nestlings are fed almost exclusively on insects—cutworms, beetles, and grasshoppers being the principal items.
5. Nestling meadowlarks consume about their own weight of food every day. They gain very nearly one fourth of an ounce in weight each day they are in the nest.

### LABORATORY EXAMINATION OF STOMACHS.

#### COLLECTION OF NON-GAME BIRDS.

Collections of birds in sufficient numbers to furnish reliable data, collected every two weeks during the year, and from over twenty-five different localities in the State, have been made available through the co-operation of the deputies of the Commission. Each bird has been tagged with data as to date, time of day, locality, kind of field or orchard, and name of collector. They have then been preserved in formalin solution and shipped to the University. On the arrival of shipments at the laboratory the stomach has been removed and data as to the species and sex of the different birds added. The tag bearing complete data has then been wrapped with the stomach in a small cloth and preserved in formalin solution until microscopically examined. Although the collection of non-game birds by the deputies for the investigation has often been interfered with by the absence of the deputy on important work, or by the replacing of deputies, yet series of birds taken each month of the year in sufficient numbers to furnish reliable evidence as to their food are at hand from many different localities in the State. So far as possible all incomplete series will be completed this coming year.

In order that the work in 1911 might be verified, collections have been continued in several places during 1912. This will afford a comparison of the food in two succeeding years.

The accompanying map (Fig. 3.) shows the localities in which collections have been made. The localities from which complete series were made and those localities from which incomplete series have been obtained are indicated.

A correct determination of the economic status of a bird is largely dependent on a knowledge of its food. The food of a bird can be

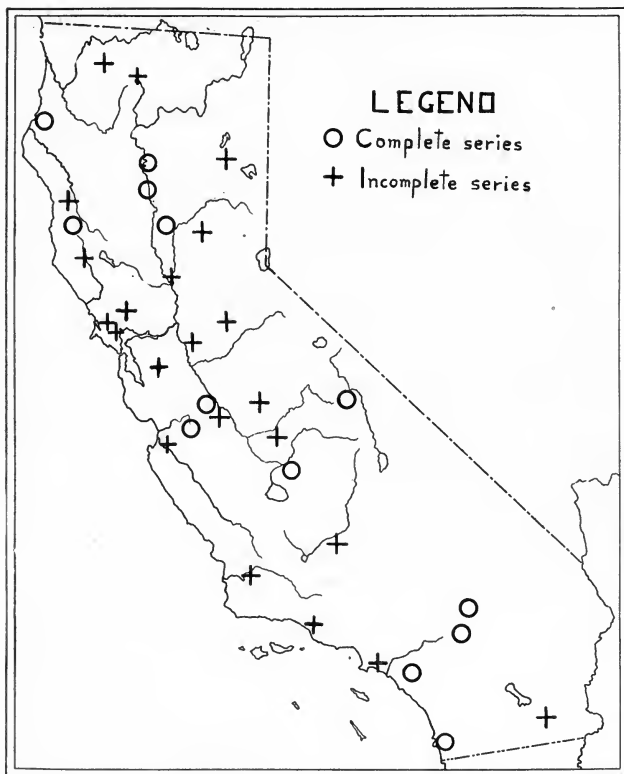


FIG. 3.—Map of California showing localities from which non-game birds have been collected for stomach examination.

#### EXAMINATION OF STOMACH CONTENTS.

roughly determined by watching the bird in the field. The most dependable data concerning the food of most birds, however, is obtained by examining the contents of the bird's stomach. Consequently stomach examination has been largely depended upon to furnish needed evidence as to the food of the birds under investigation.

In the examination of the stomach contents a Zeiss binocular has been used. After the contents has been carefully removed from the stomach and placed on a glass plate, the binocular is used in sorting, counting,

and identifying the different kinds of food. A determination of the number of insects, seeds, etc., is made by counts. The number of grasshoppers and crickets eaten is determined by a count of the paired mandibles found. The undigested skins furnish evidence as to the number of cutworms; and the number of heads found determines the number of beetles and bugs. The data both as to the bird and the stomach contents is then recorded on a stomach blank. The stomach contents has been preserved in small vials in every case, so that a verifi-

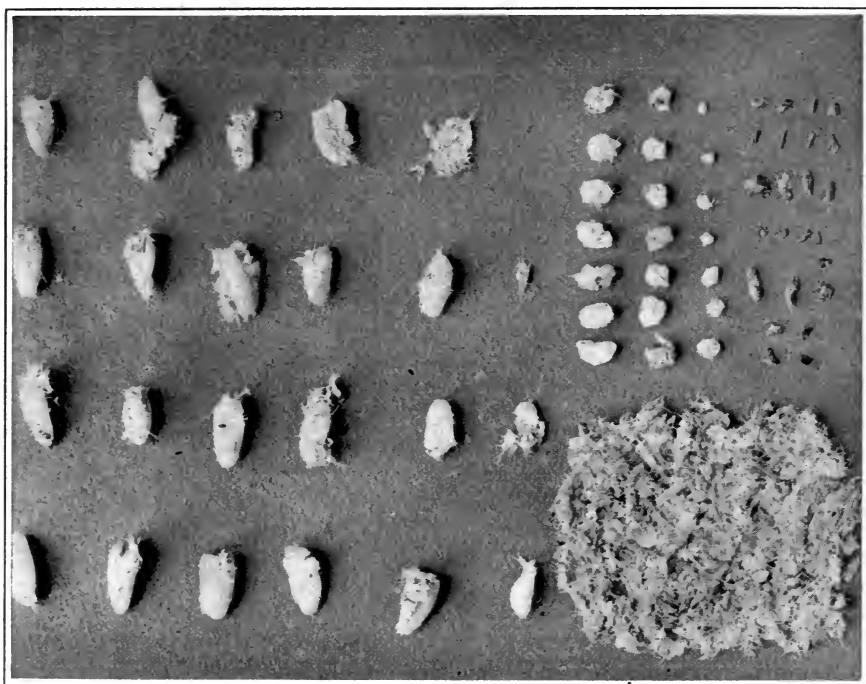


FIG. 4.—Photograph of the stomach contents of a western meadowlark, taken in a grainfield at El Toro, Orange County, California, May 5, 1911. The stomach contained 19 oat kernels, oat hulls, and parts of two small beetles. (Original.)

cation of the work is possible at all times. Final data is recorded on large blanks, which, when bound together, will give a complete record of each stomach examined.

The following is a summary of the stomachs microscopically examined in the laboratory, from January 1, 1911, to June 30, 1912:

*Bird Stomachs Microscopically Examined January 1, 1911, to June 30, 1912.*

Western meadowlarks.	Red-winged blackbirds.	Brewer blackbirds.	Western robins.	Horned larks.	Western mourning doves.	Rockhoppers.	Woodpeckers.	Western Kingbirds.	Oracles.	Starlings.	Miscellaneous.	Total.
831	63	9	46	2	9	1	15	2	6	2	25	1,011

# IDENTIFICATION OF STOMACH CONTENTS.

The different insects, seeds, etc., found in a bird's stomach are often so finely comminuted that they are difficult to identify. Much of the material, however, it has been possible to determine as far as the family, and in many instances to the genus and species. The food contained in a bird's stomach can usually easily be separated into two classes—animal food and vegetable food. The animal food consists largely of insects, and the vegetable food of grain and weed seeds (Fig. 4). Reference collections of insects and weed seeds have afforded material for comparison. Identification by government experts has often been resorted to.

## SOME FACTS BROUGHT OUT BY THE STOMACH EXAMINATION.

Among the insects found in the stomachs of western meadowlarks, the following are the most common:

### Orthoptera.

Cricket .....	<i>Gryllus pennsylvanicus.</i>
Jerusalem cricket .....	<i>Stenopelmatus californicus.</i>
Grasshopper .....	<i>Dissosteira spurcata.</i>
Valley grasshopper .....	<i>Oedaleonotus enigma.</i>
Differential grasshopper .....	<i>Melanoplus differentialis</i>
Grasshopper .....	<i>Shistocerca</i> sp.

### Hemiptera.

Squash-bug .....	<i>Anasa</i> sp.
Stink-bug .....	<i>Podisus</i> sp.
Stink-bug .....	<i>Pentatoma</i> sp.
Leafhopper .....	<i>Stictocephala franciscana.</i>
Negro-bug .....	<i>Corimelana anthracina.</i>

### Diptera.

Cicada .....	<i>Platypedia</i> sp.
Flower-fly .....	<i>Eristalis tenax.</i>
Flower-fly .....	<i>Syrphus.</i>
Ground-beetle .....	<i>Pterosticus</i> sp.
Ground-beetle .....	<i>Anisodactylus dilatus.</i>
Pinicate bug .....	<i>Eleodes</i> sp.
Carriion-beetle .....	<i>Silpha</i> sp.
Rove-beetle .....	<i>Staphylinus</i> sp.
Click-beetle .....	<i>Drasterius</i> sp.
	<i>Limonium californicus.</i>
	<i>Limonium canis.</i>
Devil-beetle .....	<i>Phloeodes diabolicus.</i>
	<i>Platynus ovipennis.</i>
	<i>Coniontis subpubescens.</i>
	<i>Calathus ruficulus.</i>
	<i>Blapstinus</i> sp.
California flower-beetle .....	<i>Diabrotica soror.</i>
Leaf-beetle .....	<i>Disonycha</i> sp.
	<i>Cardiophorus tenebrosus.</i>
	<i>Saprinus fimbriatus.</i>
Grain weevil .....	<i>Sphenophorus</i> sp.

### Hymenoptera.

Cuckoo-fly .....	<i>Chrysis</i> sp.
Bumblebee .....	<i>Bombus californicus.</i>
Carpenter ant .....	<i>Camponotus</i> sp.
Harvester ant .....	<i>Messor andrei.</i>
California agricultural ant .....	<i>Pogonomyrne californicus.</i>
Wasp .....	<i>Vespa</i> sp.
Cow-killer .....	<i>Spharophthalma californica.</i>



Beetles are taken each month of the year. Cutworms form a large percentage of the food during the spring, whereas grasshoppers and crickets form the largest part of the food during the summer and fall months (Fig. 5, Fig. 6). Certain plant bugs, wild bees, wasps, ichneumon flies, and ants are also taken to a less extent. Spiders, scorpions, ant lions (*Myrmeleon* sp.), centipedes (*Scolopendra* sp.), thousand-legged worms (*Tulus* sp.), and sowbugs have also been found.

Grain has been found in considerable quantity in the stomachs of meadowlarks. Oats appears to be preferred, although wheat is often found. The wild variety of oats (*Avena fatua*) far exceeds in amount the cultivated varieties. Very little of that found in the stomachs is sprouted. Field investigation showed that sprouted grain is often crushed in the bill to get the milk, and then dropped on the ground.

Seeds of the following common weeds have been taken from the stomachs of western meadowlarks:

Sorghum	-----	<i>Andropogon sorghum.</i>
Canary-grass	-----	<i>Phalaris</i> sp.
Darnel	-----	<i>Lolium temulentum.</i>
Amaranth	-----	<i>Amaranthus</i> sp.
Buttercup	-----	<i>Ranunculus</i> sp.
Knotweed	-----	<i>Polygonum</i> sp.
Mustard	-----	<i>Brassica</i> sp.
Bur-clover	-----	<i>Medicago denticulata.</i>
Clover	-----	<i>Trifolium</i> sp.
Sweet clover	-----	<i>Melilotus</i> sp.
Alfalfa	-----	<i>Medicago arabica.</i>
Dock	-----	<i>Rumex crispus.</i>
Alfilaria	-----	<i>Erodium cicutarium.</i>
Turkey weed	-----	<i>Eremocarpus setigerus.</i>
Amsinckia	-----	<i>Amsinckia intermedia.</i>
Nightshade	-----	<i>Solanum</i> sp.
Bedstraw	-----	<i>Galium</i> sp.
Tarweed	-----	<i>Hemizonia</i> sp.
Star-thistle	-----	<i>Centaurea melitensis.</i>
Zea	-----	<i>Zea mays.</i>

The relative proportions of animal and vegetable matter taken by western meadowlarks in California has been fairly well demonstrated by the stomach examinations. The average amounts of the different kinds of food consumed by 650 meadowlarks taken at six different localities in the State (Red Bluff, Tehama County; Live Oak, Yolo County; Newman, Stanislaus County; Hanford, Kings County; Big Pine, Inyo County, and San Diego, San Diego County), when platted in the form of a curve, show the following results (Fig. 8). The minimum amount of animal food (4.15 per cent) is taken in January, and the maximum 93.83 per cent) in July. During the spring months there is a sudden increase in the amount of animal food taken, whereas a sudden decrease is to be noted in the fall months. The percentage closely parallels the availability of insect food. The maximum amount of cutworms is taken in May and June; the maximum number of grasshoppers in July and August. Grain as an element of food reaches a maximum in January and a minimum during July. The maximum consumption of weed seeds is in October.

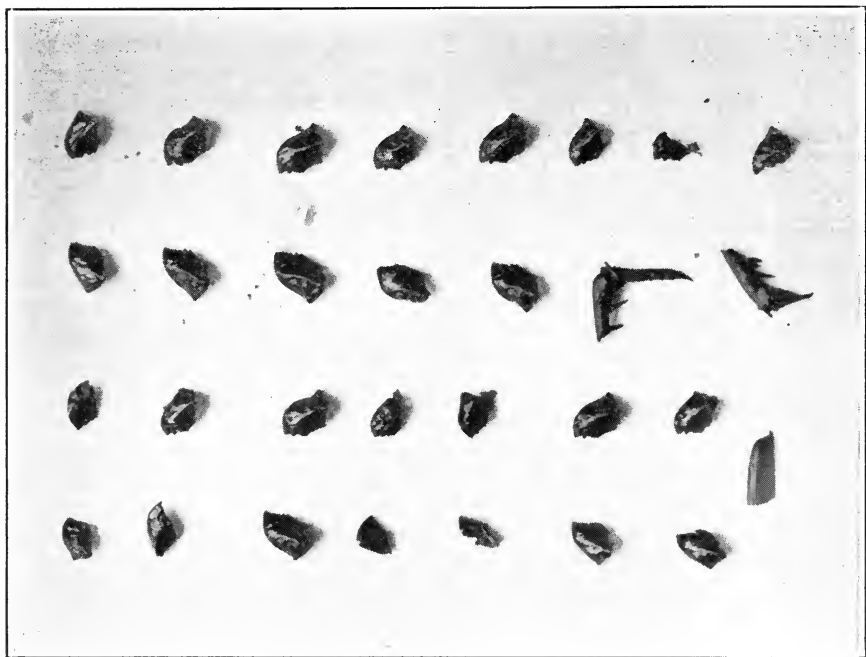


FIG. 5.—Photograph of twelve pair of mandibles of the common cricket (*Gryllus* sp.) taken from the stomach of a western meadowlark collected in a grain field at El Toro, Orange County, California, April 18, 1911. (Original.)

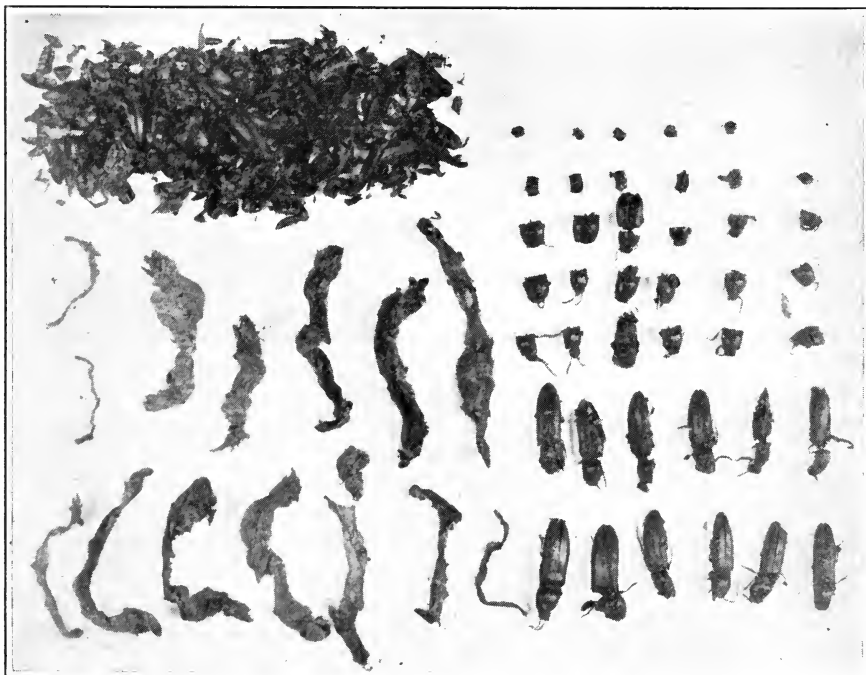


FIG. 6.—Photograph of stomach contents of a western meadowlark collected at Big Pine, Inyo County, California, April 19, 1911. The stomach contained 13 cut-worms, 26 elaterid beetles (*Drasterius* sp.), and ten small ground beetles. (Original.)

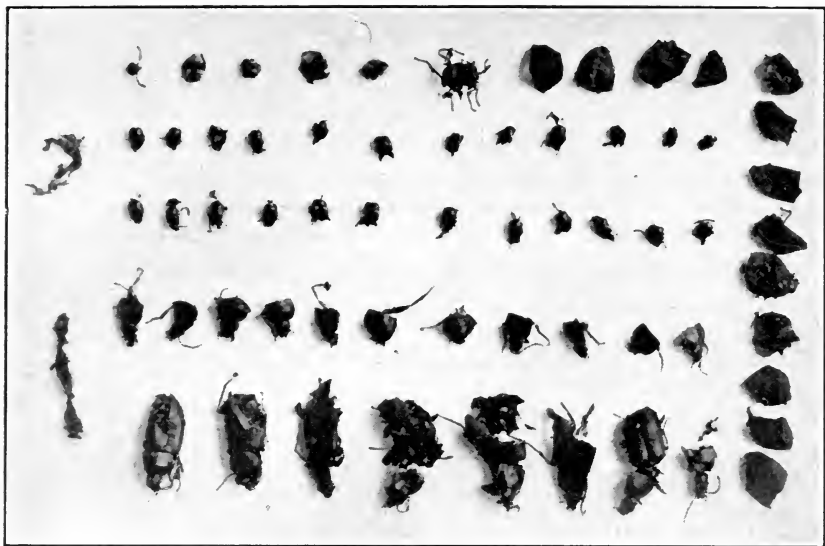


FIG. 7.—Photograph of stomach contents of a western meadowlark taken in a barley field at El Toro, Orange County, California, May 3, 1911. The stomach contained 2 cutworms, 44 ground beetles (*Calathus ruficollis*), 2 flies, 1 spider, and 13 fly pupae (*Syrphus*). (Original.)

The total food for the year consists of 58.6 per cent of animal matter and 41.4 per cent of vegetable matter. This result differs considerably from that of Beale (Birds of California, U. S. Dept. Agric., Div. Biol. Surv., Bull. 34, 1910, p. 66). In the examination of 91 meadowlarks collected in California Dr. Beale found 70 per cent of animal and 30 per cent of vegetable matter. The difference may be due to the fact that most of the birds examined by the writer were evenly distributed through the year and were collected in localities where grain was obtainable. This larger percentage of vegetable matter does not necessarily minimize the value of the bird, for a large part (30 per cent) is made up of weed seed. It seems reasonable to believe that the examination of a larger number of stomachs of meadowlarks will not appreciably change these results. It can be expected, however, that additional data will smooth out the accompanying curve.

Stomach examination of red-winged blackbirds has demonstrated the fact that they feed to a considerable extent on vegetable matter, weed seed being the principal element. Cutworms and grasshoppers form a large percentage of the food when they are available.

Brewer blackbirds take a larger percentage of animal food than do the red-wings. They appear to be especially beneficial in the destruction of cutworms, wireworms, and grasshoppers.

Too few stomachs have been examined to give any adequate idea of the food-habits of the western robin. The material found in the stomachs examined has been composed largely of wild fruit and cutworms. One hundred and ninety-two small cutworms were found in one of the stomachs.

Stomach examinations of the mourning dove has shown the bird to be very valuable as a destroyer of weed seeds. Its great capacity (several thousand seeds having been found in a single stomach) and its fondness for the seeds of such weed pests as the mustard, turkey mullein, and tumble weed attest its value. A very strong sentiment in favor of placing this bird on the protected list is rapidly being developed in this

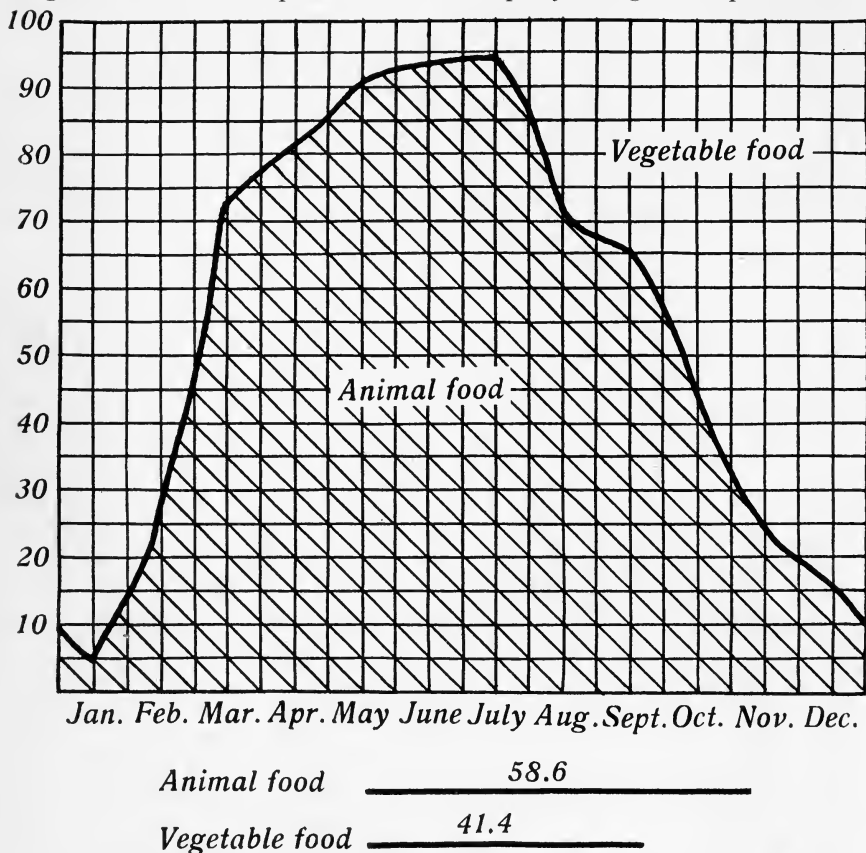


FIG. 8.—Diagram showing the proportion of animal and vegetable food of the western meadowlark (*Sturnella neglecta*) for the year.

State. Further work will certainly but demonstrate anew the value of this bird to agricultural interests.

Judging from the examination of one stomach, the investigation of the food-habits of the roadrunner will reveal some astonishing facts as to its capacity and food. The following was found in the stomach:

- 12 grasshoppers.
- 1 cicada fly (*Platypedia* sp.)
- 2 noctuid moths.
- 1 ant lion (*Myrmeleon* sp.)
- 2 robber flies.
- 2 beetles.
- 6 bumble bees.
- 4 spiders.
- 1 harvest mouse (*Reithrodontomys longicauda*).
- 1 egg mass.

# VIEWS OF THE MEN CONCERNED.

In order that the men most directly concerned might furnish evidence as to the economic value of the meadowlark, a list of questions has been sent out to ranchers throughout the State. The response to these circular letters has not been as great as was hoped it might be. More of the blanks will be distributed this coming year, so that a fairer idea of the opinion of ranchers may be obtained. The questions, with a summary of the answers received, follow:

DEAR SIR: The State Fish and Game Commission has taken up the study of the meadowlark in its relation to agriculture and desires to know what you think of the bird. In order to secure comprehensive and uniform data answers to the following questions are urgently requested:

1. Name\_\_\_\_\_ 2. Address\_\_\_\_\_
3. Occupation \_\_\_\_\_
4. How many acres of land do you own?\_\_\_\_\_ Is your ranch hilly, upland or bottom land?\_\_\_\_\_
5. What is the principal crop raised?\_\_\_\_\_ What other crops? \_\_\_\_\_
6. Has the meadowlark done any harm on your place?\_\_\_\_\_ If so, how and to what extent?\_\_\_\_\_
7. Have you examined the stomachs of any meadowlarks to ascertain their food?\_\_\_\_\_ If so, what was in the stomach?\_\_\_\_\_
8. Approximately, how many meadowlarks are seen daily on your place?\_\_\_\_\_ Are the numbers any greater when the grain is sprouting?\_\_\_\_\_
9. Do you prize the meadowlark as a song bird?\_\_\_\_\_
10. On the whole do you consider the meadowlark a nuisance?\_\_\_\_\_

When the returns as to whether the meadowlark is a nuisance, and as to whether it causes damage to crops are classified as to counties, the results are as follows:

Locality.	Number reporting.	Is the meadowlark a nuisance?		Does the meadowlark damage crops?	
		Yes.	No.	Yes.	No.
Coast counties _____	13	3	9	4	9
Central valley counties _____	39	20	13	24	15
Northern California _____	76	28	41	33	43
Southern California _____	12	1	10	2	10

The results show that a majority of those who have taken the trouble to answer the circular letter do not consider the meadowlark a nuisance. When the answers are classified as to counties, it becomes evident that the bird does practically no harm in Southern California. The greatest amount of complaint comes from the San Joaquin Valley. This can be easily explained. Grain is the usual crop raised in this locality, and meadowlarks are more abundant here than elsewhere. The combination of these two factors explains the reason for this greater complaint. These reports have substantiated the conclusions reached in field work—damage to sprouting oats is greatest; damage to melons has been exaggerated.

#### DETERMINATION OF THE ECONOMIC STATUS OF A BIRD.

Birds were originally catalogued as injurious or beneficial from circumstantial evidence. If a bird was seen in the grainfield or in the orchard it was forthwith condemned as injurious. The modern method of determination rests on the respective percentage of injurious as against beneficial insects, and the percentage of weed seeds taken by a bird. Too often this method takes too little account of the depredations of the bird and of its general habits and interrelations. A balancing of the sum of all the good done by a bird with the sum of all the evil, appears to most nearly determine its economic value. It is this method that is being used in the investigation. The life histories of each bird under investigation, its depredations, migrations, and food habits are all receiving attention, so that its interrelations may be as well known as its food.

#### PROGRESS OF THE WORK.

Considerable data regarding the depredations, food habits, etc., of the birds under investigation and other birds has been accumulated through field work. Reliable evidence in the form of photographs has been obtained wherever possible. Arrangements have been made to furnish certain high schools in the State with needed material made available by the investigation.

Through the co-operation of the deputies of the Commission, some forty-five hundred bird stomachs have been collected and preserved and are now awaiting examination. The stomachs of over one thousand birds have been examined in the laboratory. Over eight hundred and thirty of them have been those of meadowlarks. Many of the insects and weed seeds found in the stomachs have been identified. Reference collections of insects and weed seeds have been started. Certain interesting scientific data concerning distribution, variation, malformation, and parasitism has come to light in the laboratory work. A considerable amount of correspondence has been carried on, and a circular letter regarding the meadowlark has been sent to ranchers throughout the State.

The attempt has been made to keep the people of the State in touch with the work by means of newspaper articles. Each field investigation has been advertised in the local newspapers and full reports published and circulated. Notes on the progress in the examination of stomachs have also been published. Up to date the following reports have been published:

"Is the Meadowlark the Farmer's Friend?" *Pacific Rural Press*.

Letter written by H. C. Bryant, assistant in charge of Bird Investigation, to the editor of the San Bernardino Sun. *California Fish and Game Commission*, Bull. No. 1, pp. 13-14.

"The Relation of Birds to an Insect Outbreak in Northern California During the Spring and Summer of 1911." *The Condor*, 13, 195-208.

"The Economic Status of the Meadowlark in California." *The Monthly Bulletin of the State Horticultural Commission*, 1, No. 6, pp. 226-231.

"The Lewis Woodpecker—a Destroyer of Almonds." *The Monthly Bulletin of the State Horticultural Commission*, 1, No. 8, pp. 363-366.

Several lectures bearing on the work have been given. Additional opportunity in this direction has been furnished by extension work on the University Agricultural and Horticultural Demonstration Train. During the season 1911-1912 this train covered over 5,000 miles, made nearly 250 stops, and entertained 102,000 people. An exhibition of "Native Birds and Mammals," consisting of collections of native birds and mammals arranged and labeled so as to show how each affects the farmer, and stomach contents, charts, and photographs illustrating the food habits of the common birds, afforded the farmers of the State some of the results of the investigation. On the other hand, it afforded opportunity to become better acquainted with the complaints of the men most concerned.

A report of work done in connection with the exhibit of "Native Birds and Mammals" on the Agricultural Demonstration Train of the season 1910-1911, and an "Annual Report" have also been made to your honorable board.

#### WORK IN PROSPECT, AND DEMANDING ATTENTION.

The attempt will be made to complete the study of the western meadowlark by the first of the year. The results will be published in the form of a bulletin.

The field work will continue the determination of the extent of the depredations of the birds under investigation, the experimental determination of the kind and amount of food and the time of digestion, and studies of the relation of birds to insect outbreaks. An investigation of the relation of birds to a grasshopper outbreak is already under way.

The main part of the work will consist in completing, as far as possible, the examination of the stomachs now on hand, the tabulation of the acquired data, and the publication of final reports on the birds under investigation. Papers on the following subjects are in process of preparation:

"Native Birds and Mammals."

"The Present Status of the California Valley Quail."

"Birds in Relation to a Grasshopper Outbreak in California."

"The Food-habits of the Meadowlark in California."

"A Study of the Determination of the Economic Status of Birds."

"The Food-habits of the Roadrunner."

"The Blackbirds of California in Their Economic Relations."

"The Mourning Dove as a Weed Seed Destroyer."

The game in the State of California is no small asset. Its conservation is important. Much work as regards the life histories of the game birds of the State needs to be done. In a good many instances little is known of the abundance, distribution, migrations, and food-habits of our game birds. Such knowledge is necessary for proper protection and legislation. This department plans to extend its investigations to the game birds of the State, so that positive data regarding them will be available. A paper on "The Present and Future Status of the California Valley Quail," printed in this bulletin, is a preliminary report on this, California's most valuable game bird.

The figure consists of two parts. The top part is a 3D perspective view of a single hexagonal unit cell. The vertices are labeled with lowercase letters: a, b, c, d, e, f. Inside the hexagon, there are several points labeled with lowercase letters: g, h, i, j, k, l, m, n, o, p, q, r, s, t, u, v, w, x, y, z. The bottom part is a 2D top-down view of a larger section of the hexagonal lattice. The vertices are labeled with uppercase letters: A, B, C, D, E, F, G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V, W, X, Y, Z. The lattice is composed of many hexagons arranged in a regular pattern.





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